Transmitted by the expert from the Netherlands

Informal document GRB-65-22
(65th GRB, 15 – 17 February 2017,
agenda item 11)

Labelling road surfaces

Berry Bobbink
Province of Gelderland

Arian de Bondt
Ooms Civiel

Gerard Oude Lansink
Reef Infra

Remco Hermsen
Province of Gelderland

Frank Bijleveld
Ooms Civiel

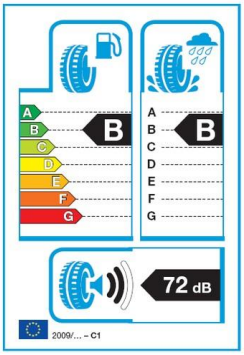
Summary
Labelling of road surfaces is a categorisation (from A to G) of requirements and guidelines (current and future) for road surfaces, similar to ones for houses and tyres. The purpose of road surface labelling is easier, transparent communication between the client and contractor, between road authorities and road users, taxpayers and residents. Moreover, it promotes a recognition towards society and politics. The road surface label can also be used in the management phase, and in determining the replacement time in advance.
The labelling of road surfaces should lead to official recognition of a road surface (the driving surface) as a product that is industrially designed, built and maintained. In addition, it facilitates cooperation between the road industry and tyre industry and other relevant partners, resulting in faster innovation cycles (shorter turnaround of new products) and true optimisation of tyre-road interaction.
The targeted approach to achieve road surface labels is focused on the Dutch procedure for noise reduction, which means at least 5 measured representative road sections measured by an independent certification body for the release of road surface labels. The labels should be categorised on the basis of validated methods (preferably in the laboratory).
Road surface labels are a step towards professionalisation and industrialisation of the road industry and tyre industry. The paper has established the labels for certain topics: wet skid resistance, noise and rolling resistance on the one hand (as in the labelling of tyres) and lifespan, residual lifetime capacity, comfort/vibration, transverse flatness, ravelling, cracking and durability. Finally, the paper describes a vision and approach to achieve future progress with road surface labelling.

Key words: Labelling, road surface labels, noise, rolling resistance, skid resistance, durability, industrialisation.

* This paper has been presented at the Dutch Infra Congress 2016 on the 23rd of June 2016.

1. Introduction road surface labels

Labels for products are a categorisation of requirements and guidelines, often from A (good) to G (abysmal). Examples include energy labels for washing machines, buildings and cars, but the labels may also concern properties other than energy. Another example is tyre labels on which fuel consumption, wet skid resistance and noise properties of tyres are displayed. This paper introduces the concept of labels for road surfaces.



The purpose of the labelling of road surfaces is easier and transparent communication between the client and contractor, and between road authorities and road user/taxpayer and local residents. It also promotes recognition towards society and politics. In addition, it helps to make choices between different road surfaces. The road surface label can also be used in the management phase, and in determining the replacement time in advance. Moreover, it facilitates the collaboration with tyre manufacturers and other relevant industry partners, resulting in faster innovation cycles (shorter lead times of innovations) and system innovations rather than innovations at the level of individual sectors. Indeed, a tyre can be optimised for a particular type of road surface, but might be less optimised for another type. If these two sectors - the tyre industry and road construction industry - understand each other better, tyre-road interaction can be optimised as a whole. It makes the optimisation of the coherence of tyre-road surface really possible.

The main preconditions for road labels are:

- Compatibility with the existing tyre label;
- Suitable for current and future vehicle fleet;
- Includes (only) essential road surface features - for both new and existing roads;
- Must allow for (meaningful) innovation (product and process);
- Must cover about 5 to 10 families of road surfaces, Europe-wide.

The purpose of this paper is to create and to explicitly communicate the concept of road surface labels, to describe an approach for achieving road surface labels and finally to stimulate industrial design, construction and maintenance of road surfaces.

Section 2 corroborates on the main results of the previous European research project ‘Safe and silent road traffic’ (Dutch: Stil Veilig Wegverkeer). This project was a previous collaboration between the tyre industry, road construction contractors and knowledge institutions. Section 3 describes the proposed approach to achieve road surface labels and section 4 proposes road labels of different properties. To conclude, the paper describes a vision and approach to achieve future progress with road surface labelling.

2. Results previous European research project 'Safe and silent road traffic'

Quieter and safer tyres and road surfaces contribute to the quality of life and reduce accidents. The amount of noise and wear depends strongly on how the tyre and road surface react when in contact with each other. For this reason, the project 'Safe and silent road traffic' tackled improvements to tyre and road surface in connection with each other. A prototype of a 'quiet and safe tyre-road surface combination' was created. Tyre and asphalt were both made quiet and safe. What makes this project unique is the partnership between university, tyre supplier and road builder, in which the interaction between tyre and road surface is central.

The main objectives of the project were:

- Knowledge: Development of fundamental insights into the tyre-road surface interaction 'grip' and 'noise';
- Valorisation: Development of innovative quiet and safe tyre-road surface combinations;
- Social relevance: Quieter, safer road traffic and retention/growth employment.

During the project, new measurement tools, simulation tools and prototypes were developed and tested. The main results of this study are:

- Measuring instruments
    - 3D roughness road+water. Development, design and construction of a measuring tool for 3D scanning of asphalt on mm-scale and µm-scale;
    - Contact temperature. Development, design and construction of a 2D temperature sensor (using existing infrared technology), to measure the temperature gradient in time and position of road surface and tyre simultaneously at high speeds (80 ~ 100km/h);
    - Integration trailer with the above measuring equipment.
- Traction and skid resistance
    - Test methods on lab level of Surface Force Apparatus (SFA) and LAT100 (rubber test wheel) and outdoor on tyre-road surface level of a measurement trailer;
    - Traction on SFA, LAT100 and measurement trailer with various rubbers/road surfaces, wet and dry;
    - Validation of a friction model for traction on dry tyre-road surface contact which describes the above measurement results;
    - Calculating safe rubber-road surface combination.
- Noise
    - Knowledge of dynamic tyre-road surface contact;
    - Measurement and validation of detailed modelling of the tyre-road surface contact in current complete physical tyre-road surface noise model;
    - Calculating the silent tyre-road surface combination.
- Prototypes
    - Design and production of quiet and safe tyre-road surface combinations;
    - Demonstration quiet and safe tyre-road surface combinations.

This initiative 'Labelling road surfaces' is a sequel to the project 'Safe and silent road traffic'.

3. Development of the approach for road surface labels

The proposed methodology to arrive at a road surface label per item (requirement/directive) is based on the Dutch procedure to determine noise reduction for roads:

- Independent certifying bodies for the release of road surface labels;
- Validated methods (in situ/laboratory) per label. To this end, a reassessment of the requirements and guidelines is important (sometimes requirements stem from 'old' best practices, but it is unclear whether the current practice is still valid/relevant);
- At least five measured representative road sections;
- Product development not on the road itself (risky and time-consuming), but as much as possible via (advanced) test methods in the laboratory;
- Requirements regarding labelling are well supported at project level, including statistical reliability of the requirements.

4. Road surface labels

A successive elaboration was made of a number of road surface labels. First, the properties that are on tyre labels are considered (wet skid resistance, noise and rolling resistance). Afterwards, labels for functional and mechanical properties of the road surface are discussed.

Wet skid resistance

The labelling for wet skid resistance is elaborated below on the basis of the Dutch regulations, i.e test 72 and 150 at different speeds.

Road label	Friction coefficient according to test 150 at 70 km/h
A	0.75 or more
B	0.75 to 0.60
C	0.60 to 0.54
D	0.54 to 0.45
E	0.45 to 0.38
F	0.38 to 0.3
G	0.3 or less
Road label	Friction coefficient according to test 150 at 50 km/h
A	≥ 0.75
B	0.60 to 0.75
C	0.52 to 0.60
D	0.45 to 0.52
E	0.38 to 0.45
F	0.30 to 0.38
G	< 0.30

Road surface label	Friction coefficient according to test 72 at 70 km/h	
	Open road surfaces	Dense road surfaces
A	≥ 0.83	≥ 0.78
B	0.68 to 0.83	0.63 to 0.78
C	0.59 to 0.68	0.55 to 0.63
D	0.50 to 0.59	0.47 to 0.55
E	0.42 to 0.50	0.39 to 0.47
F	0.33 to 0.42	0.29 to 0.39
G	< 0.33	< 0.29

Road surface label	Friction coefficient according to test 72 at 50 km/h	
	Open road surfaces	Dense road surfaces
A	≥ 0.88	≥ 0.86
B	0.73 to 0.88	0.71 to 0.86
C	0.63 to 0.73	0.62 to 0.71
D	0.54 to 0.63	0.53 to 0.62
E	0.45 to 0.54	0.44 to 0.53
F	0.35 to 0.45	0.33 to 0.44
G	< 0,35	< 0.33

In the long term, the wet skid resistance for open road surface types will be cancelled. The first line of thought is given to further use of basic research (e.g. European research project SKIDSAFE) and complementing gaps on this subject. The relationship between open road surfaces and tyres etcetera is not sufficiently in line with current measurement and interpretation research.

Noise

The labelling for noise (noise reduction and noise level) is described below on the basis of the Calculation and Measurement Regulations Noise (RMG 2012) at different speeds for different types of vehicles.

Road label	Compared to the RMG 2012 (80km/h) light motor vehicles
A	Noise reduction 11 dB(A) or more initially
B	Noise reduction 11 to 8 dB(A) initially
C	Noise reduction 8 to 5 dB(A) initially
D	Noise reduction 5 to 2 dB(A) initially
E	Noise reduction 2 to - 1 dB(A) initially
F	Noise reduction -1 to - 4 dB(A) initially
G	Noise reduction -4 dB(A) or less initially

Road label	Compared to the RMG 2012 (80km/h) light motor vehicles
A	Sound level 66,2 dB(A) or lower initially
B	Sound level 66.2 to 69.2 dB(A) initially
C	Sound level 69.2 to 72.2 dB(A) initially
D	Sound level 72.2 to 75.2 dB(A) initially
E	Sound level 75.2 to 78.2 dB(A) initially
F	Sound level 78.2 to 81.2 dB(A) initially
G	Sound level 81.2 dB(A) or higher initially

Road label	Compared to the RMG 2012 (70km/h) heavy motor vehicles
A	Noise reduction 10 dB(A) or more initially
B	Noise reduction 8-10 dB(A) initially
C	Noise reduction 6-8 dB(A) initially
D	Noise reduction 4-6 dB(A) initially
E	Noise reduction 2-4 dB(A) Initial
F	Noise reduction 2 to - 1 dB(A) initially
G	Noise reduction -1 dB(A) or less initially

Road label	Compared to the RMG 2012 (70km/h) heavy motor vehicles
A	Sound level 74.4 dB (A) or less Initially
B	Sound level 74.4 to 76.4 dB (A) initially
C	Sound level 76.4 to 78.4 dB (A) initially
D	Sound level 78.4 to 80.4 dB (A) initially
E	Sound level 80.4 to 82.4 dB (A) initially
F	Sound level 82.4 to 85.4 dB (A) initially
G	Sound level 85.4 dB (A) or higher initially

Below are the road surface labels for noise (sound level = GLW 1 and noise reduction = GLW 2) worked out for the standard road surfaces for light motor vehicles (80 km/h) in accordance with CROW publication 316 (Dutch regulation). On this basis, it is apparent that most road sections in label C fall within a range of label B to E.

Lichte motorvoertuigen		Wegdeksoort	laatste update	ΔLm		
Nr	Wegdektype/-product		(internet)		GLW 1	GLW 2
0	referentiewegdek	asfalt	01-07-12	0,0	F	E
1	1L ZOAB	asfalt	01-07-12	-3,0	E	D
2	2L ZOAB	asfalt	01-07-12	-6,3	C	C
3	2L ZOAB fijn	asfalt	01-07-12	-8,4	B	B
4a	SMA 0/5	asfalt	01-07-12	-2,9	E	D
4b	SMA 0/8	asfalt	01-07-12	-1,9	F	E
5	uitgeborsteld beton	beton	01-07-12	0,8	F	E
6	geoptim. uitgeborsteld beton	beton	01-07-12	-0,9	F	E
7	fijngebezemd beton	beton	01-07-12	0,9	F	E
8	oppervlakbewerking	asfalt / beton	01-07-12	1,7	G	F
9a	elementenverharding keperverband	elementen	01-07-12	0,8	F	E
9b	elementenverharding niet in keperverband	elementen	01-07-12	4,4	G	G
10	stille elementenverharding	elementen	01-07-12	-3,5	E	D
11	dunne deklagen A	asfalt	01-07-12	-5,5	D	C
12	dunne deklagen B	asfalt	01-07-12	-6,7	C	C

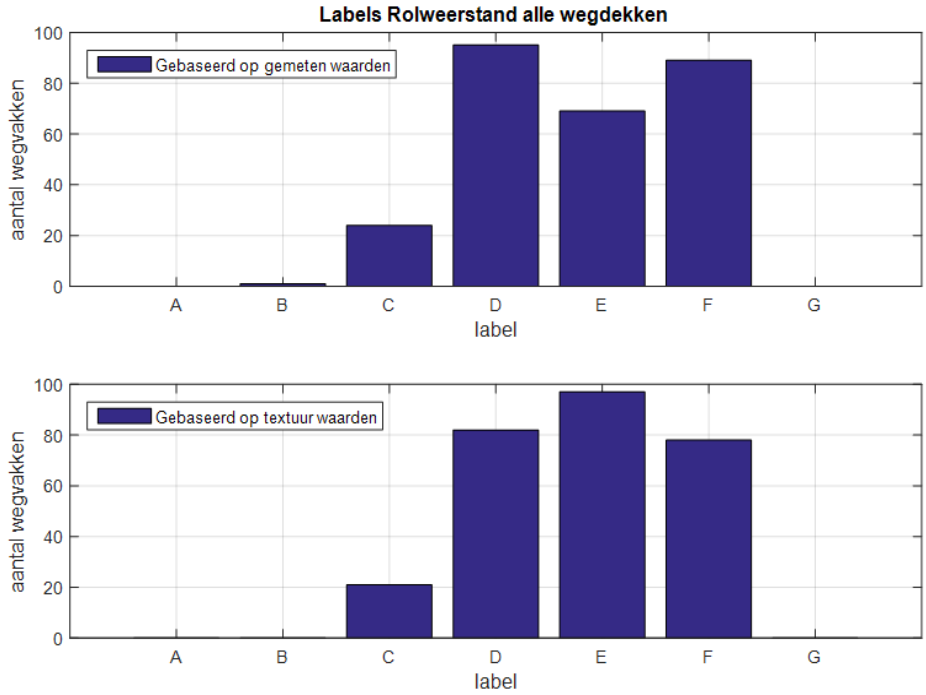
Finally, preliminary research may also take place in the laboratory using test plates and an acoustic calculation model (Acoustic Optimisation Tool (AOT).

Rolling resistance

The labelling for rolling resistance is elaborated below, based on the Rolling Resistance Coefficient (RRC) determined by the rolling resistance texture model of the province of Gelderland/Rijkswaterstaat or by taking measurements with a rolling resistance measuring trailer (TU Gdansk/OCW Belgium/BaSt Germany). The RRC is the average of all sections that are taken into account in determining the sound label of a product.

Road label	The RRC (Rolling resistance coefficient) in kg/t
A	7.5 or less
B	7.5 to 8
C	8 to 8.5
D	8.5 to 9
E	9 to 9.5
F	9.5 to 10.5
G	10.5 or more

Based on the above label format for the RRC, in the figure below the label distribution is visualised for the road sections in the province of Gelderland/Rijkswaterstaat research. A distinction is made between the actual measured RRC values and the values calculated by the model based on texture measurements.



Preliminary research is possible by means of texture measurements on test sheets in the laboratory, but in the future it may also be possible to determine the rolling resistance with a sophisticated laboratory test in the laboratory (ongoing research).

Durability

The label for durability is explained below on the basis of the calculated lifespan (with pavement design standards and simulation tests and/or life optimisation models) or lifespan in practice (warranty term).

Road label	Durability
A	more than 18 years
B	15 to 18 years
C	12 to 15 years
D	10 to 12 years
E	8 to 10 years
F	4 to 8 years
G	0 to 4 years

Residual lifespan (capacity)

The label for residual lifespan (capacity) is elaborated below on the basis of CROW publication 92 (in the future STRADA) for the 85% confidence curve.

Road label	**Residual lifespan* (in years)**	
A	> 50	Road is not loaded yet
B	30-50	Road is hardly loaded
C	15-30	Road can still be loaded for a long time
D	5-15	Road can be loaded for the medium-term
E	1-5	Road can still be loaded for a short time
F	0-1	Road just passable, but does not meet the requirements
G	0	Road impassable and does not meet the requirements

As a contractor we must build on an existing structure and therefore sufficient information needs to be present (national regulations and methodologies). The ratio of truck loads versus capacity reserve (Miner damage number) could also be used in this label.

Comfort/vibration
The label for comfort/vibration is shown below on the basis of the parameter International Roughness Index (IRI in m/km per 100). This could be the current C5 value from the RAW standard or a separate requirements such as the C3 value requirement in the province of Gelderland (Dutch regulations).

Road label	IRI m/km avg per 100 metres
A	0.5 or less
B	0.5 to 1.0
C	1.0 to 1.5
D	1.5 to 2.5
E	2.5 to 3.5
F	3.5 to 4.5
G	4.5 or more

Transverse evenness
The label for transverse evenness is elaborated on below on the basis of inspections with an edge of 1.2 metres. A possible alternative is to set a requirement on water layer depth in open coatings as a combination of flatness and track depth).

Road label	Transverse Flatness in mm
A	1 or less
B	1 to 5
C	5 to 10
D	10 to 14
E	14 to 18
F	18 to 25
G	25 or more

Ravelling
The label for ravelling is elaborated on below on the basis of ravelling in practice (inspections). The main principle for ravelling is that holes may not occur.

Road label	
A	Design, production and processing 100% in accordance
B	Design, production and processing 75% achieved in
C	No ravelling within five years, predictable behaviour
D	Local (starting, stopping places) damage within 5 years
E	Local (starting, stopping places) damage within 2 years
F	25% -35% (for the ruts)
G	The lane width is ravelled more than 35%

Preliminary research with advanced laboratory tests (SR-ITD, ARTe, RSAT) make it possible to predict the ravelling susceptibility of a mixture.

Cracking
The label for cracking (except transverse cracks) is elaborated on below on the basis of cracking in practice. Of interest are the height, width, eroding of the edges on the cracks.

Road label	
A	no crack formation and hence no height differences
B	light aesthetic degradation
C	any crack formation without further consequences
D	additional noise by crumbling crack edges
E	cracks which affect the structure
F	safety/large height differences due to cracking
G	unacceptable cracking in terms of construction and safety

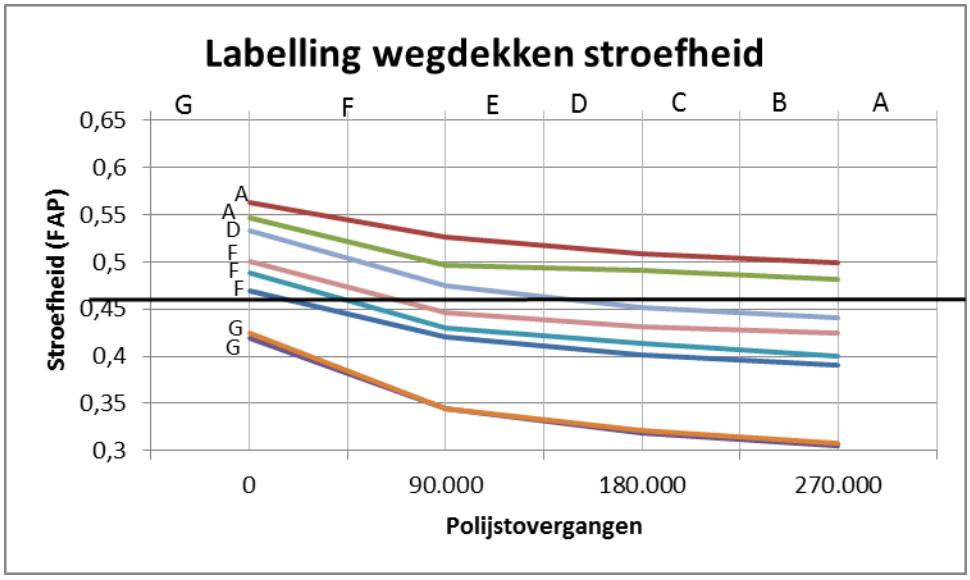
Preliminary research can be performed with cracking tests and the Rolling Bottle Test.

Dry skid resistance
The label for dry skid resistance is elaborated on below on the basis of the friction coefficient of dry braking deceleration (m/s^2) and for the future on the basis of the FAP test (Friction After Polishing).

Road label	Friction coefficient dry braking deceleration m/s^2
A	9.5 or more
B	8.5 to 9
C	7.5 to 8.5
D	6.5 to 7.5
E	5.2 to 6.5
F	4.5 to 5.2
G	4.5 or less

Road label	FAPn = 0.46 (n = number of polishing transitions)
A	> 270.000
B	225.000-270.000
C	180.000-225.000
D	135.000-180.000
E	90.000-135.000
F	0-90.000
G	0

The present methodology with dry braking deceleration needs improvement to the current insights in the long term, so that it can be used for different circumstances. The FAP test would be a suitable method to provide a long-term skid resistance indication. The figure below includes a label for mixtures of different types of stone. In this example, the requirement is a FAP-value of 0.46 and that can be concluded after how many polishing transitions this limit will be exceeded.



Further research into this experiment and the creation of a database with data from the FAP test for various mixtures and aggregate types is necessary to gain a good understanding of the differences in texture and composition of mixtures and the impact on dry skid resistance.

Durability

The labelling for durability is elaborated on below using the MKI (Environmental Cost Indicator) determined on a qualitative basis with DuboCalc (Dutch environmental tool). In the future this could continue development (numerically) on the basis of the MKI.

Road	Durability
A	not yet feasible
B	Above average
C	average as of today
D	average as of today
E	below average of today
F	worse than now
G	allow in specific circumstances

5. Conclusions and the future

This paper has described proposals for road surface labels. This labelling will facilitate the communication between client and contractor, between road authorities and road user/taxpayer and local residents. Moreover, it will promote a recognition towards society and politics. The labelling of road surfaces should lead to recognition of a road surface (the driving surface, top construction layer) as a product that is industrially designed, built and maintained. In addition, it facilitates the cooperation between the road industry and tyre industry and other relevant partners, resulting in faster innovation cycles (shorter turnaround of new products) and makes the optimisation of tyre-road interaction really possible.
Road surface labels are therefore a step forward towards professionalisation and industrialisation of the road industry and tyre industry. The aim is to move forward step by step as a sector: First we must demand and achieve label D, then label C, then label B, etc. For example, see how the CO_2 ladder has stimulated the road building industry in terms of durability.

The described implementation is a first move on the basis of practical experience and the latest scientific knowledge. It is recommended as a first follow-up step to expand the paradigm and work it out in further detail.
In addition, there needs to be further cooperation between tyre suppliers and road constructors in the future so that optimisation can occur between tyre and road surface. We will also need to learn from the introduction of labels in the tyre industry; What are best practices and what can be improved. For example, in the tyre industry many different labels have been developed (not standardised), which lead to certain confusion.
In addition, it is also important to determine how road surface labels can be incorporated into a functional demand specification and at what times requirements need to be set (immediately after delivery, end of warranty term, etc.).

Acknowledgement

This project is a continuation of the project 'Safe and silent road traffic' (Dutch: Stil Veilig Wegverkeer)' which was carried out within the framework of the European stimulus programme 'GO Gebundelde innovatiekracht'. The European Regional Development Fund, Twente Region and the Province of Overijssel subsidised the above project.

References

Bobbink, B., Fijan, J., Reinink, F., van Gils, E. (2014). Invloed van wegdektype op de rolweerstand van personenwagens op provinciale wegen. CROW Infradagen 2014, 18-19 June 2014, Ermelo, Nederland.

Eijbersen, M., van Gurp, C., Pouwels, M. (2014). STRADA: herontwerptool voor de toekomst! CROW Infradagen 2014, 18-19 June 2014, Ermelo, Nederland.

Kuijper, P., Derksen, G., Van der Bruggen, P. (2012). Validatie van de Friction After Polishing test als methode om de polijstgevoeligheid van asfaltmengsels te voorspellen. CROW Infradagen 2012, 22-23 May 2012, Papendal, Nederland.

Van der Zwan, J. (2012). Duurzaam inkopen wegverhardingen RWS. CROW Infradagen 2012, 22-23 May 2012, Papendal, Nederland.

Villani, M., Scarpas, A., Khedoe, R. de Bondt, A., Spieard, F., Kasbergen, C. (2014). On the importance of monitoring temperature in friction testing devices. CROW Infradagen 2014, 18-19 June 2014, Ermelo, Nederland.

Voskuilen, J. en Mookhoek, S. (2014). Is er niet meer uit materialen LOT te halen? CROW Infradagen 2014, 18-19 June 2014, Ermelo, Nederland.

Wennink, P., en Nagelhout, M. (2015). Onderzoek naar het aanscherpen van de vlakheidseisen op provinciale wegen in Gelderland. Rapport Ingenieursbedrijf Aveco De Bondt.

CROW (2012). De wegdekcorrectie voor geluid van wegverkeer 2012. Publicatie 316. Ede.

CROW (1995). Deflectieprofiel geen valkuil meer. Publicatie 92. Ede.

https://www.utwente.nl/ctw/trc/projecten/stilveilig_wegverkeer/.